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PHYSIOGRAPHICAL FEATURES OF ICELAND

BY

W. S. C. RUSSELL

The coast line of Iceland is extremely irregular and is characterized by deep fiords and precipitous cliffs, snow-capped and glacier-scarred. The southern coast from Vestrahorn west to Reykjanes is a broad arch bending southward bordered by vast reaches of volcanic sand mingled with diluvial deposits, especially in the broad delta of the Markarfljöt. The outer portion of this delta is fringed with a low reef of volcanic sand, mostly from Hekla, which changes with storm and tide in a treacherous manner. On the west coast, the Reykjanes peninsula and Snaefells Jökull enclose the great expanse of Faxafjord. North of Snaefells is Breidifjord, dotted with numerous islands. The northern coast is deeply cut by many magnificent fiords which receive the torrential rivers from the northern watershed. On the east, the fiords are more numerous but extend less deeply into the land.

The great central plateau is marked by a line of glaciers which are separated by sandy wastes and vast acres of glacial debris. Láng Jökull in the west, Hofs Jökull in the center and mighty Vatna Jökull in the east are the remnants of the glacial cap that formerly covered the entire country. Small glaciers are also to be found in the great northwest peninsula and in the northern highlands. Th. Thoroddsen has mapped the outlines of all the glaciers, but little has ever been attempted in the way of scientific exploration. It is true that a few ascents to portions of the glaciers have been made. Mr. W. L. Watts crossed a portion of Vatna Jökull in 1875, but nothing has been done to study these great table-land ice sheets, with their protruding volcanic peaks, to ascertain their real character. It is not known whether or not they are increasing, stationary or receding, or, if there be motion, what is the rate. The moraines are extensive and bare of vegetation in most places. Here is an attractive field for the enthusiastic explorer who is anxious to obtain scientific data.

These ice sheets are the main sources of the many rivers that radiate to all the fiords upon the coast. During the perpetual sunshine of the Arctic summer these rivers rise to torrential conditions and transport large quantities of glacial flour. Many of the streams run white with the silt and are extremely difficult to cross on ponies. The ice has a depressing effect upon the temperature in the valleys, for the Arctic winds blow across the glaciers and then sweep through the narrow valleys, especially in the north, maintaining a mean temperature during the summer months of about eleven degrees Centigrade. In the north, as we experienced in Vatnsdalr, it is not uncommon to have the sun obscured for two or three days with fog and squall and to see the haycocks sprinkled white with snow.

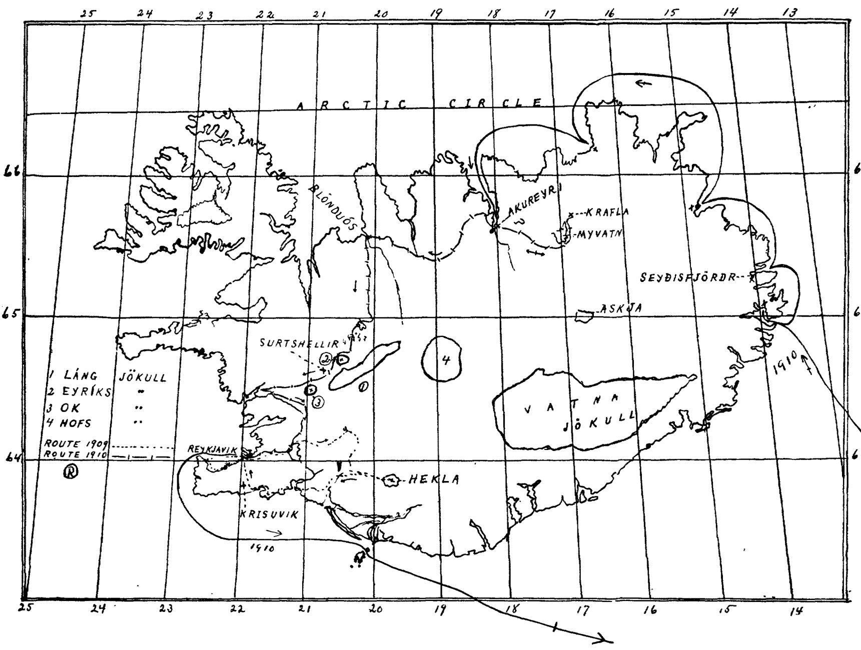

FIG. 1—Map illustrating Mr. Russell's routes in Iceland.

Hot springs abound in nearly all the valleys and even on the slopes of the snow-clad mountains. Sometimes, as at Reykholt, they are in the middle of a cold river and spout boiling water up through the surface of the running stream. This same phenomenon occurs in some of the lakes, as in Laugarvatn and Mývatn. Geysers occur in several sections, but the chief group is at Haukadalr, where the greatest geyser in the world is located. This great gusher, *Geysir,* formerly had a period of eight hours. It is now intermittent. Its cone is regular, its tube straight with a diameter of nine feet for a distance of eighty-four feet, where it disappears in subterranean ramifications. The basin is saucer-shaped, sloping inwards at an angle of about thirty degrees, with a diameter of seventy-two feet. The eruption presents a magnificent spectacle. The ground trembles for a few moments before the explosion, the surface of the water in the basin is violently agitated, sinks back to a state of quiescence, then, without further warning the superheated water is hurled into the air to a height of 100 to 125 feet. The column of water is held at this height for at least eight minutes and sometimes for ten. The sun is obscured by the dense volumes of steam, and a veritable river of boiling water rushes down the geyserite gorge. Scores of other geysers are in the plain, each with peculiar characteristics and of great interest. This place has been more carefully described in literature than any other spot in Iceland.

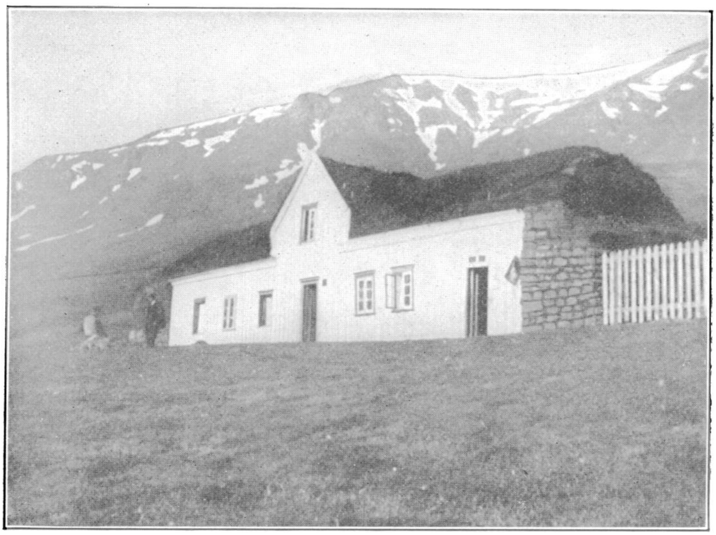

Fig. 2—Midsummer in the Oxnadalr Pass. Typical farm house. Over the house is seen a glacial valley in which fragments of the former glacier still linger. Note the semi-circular shape, characteristic of all Icelandic glaciated mountains.

Along the axes of volcanic activity and especially at the volcanic foci of the island there are many solfataras in a lively condition. They emit great volumes of steam, sulphur dioxid and carbon dioxid. Those at Krisuvik, Krafla and Mývatn are the most extensive. Many thousand tons of sulphur have been sublimed at these localities, especially at Krisuvik, where one pile is estimated to contain over 200,000 tons of nearly pure sulphur. There are two great foci of volcanic activity in the island, Hekla in the south and Krafla in the northeast. Fifty miles to the south of Krafla is Askja, which marks a strong volcanic center. It has been supposed that there is a subterranean connection between this great heated area and Hekla. This territory has not been carefully explored. The great crater of Askja was carefully examined by the late E. Delmar Morgan, F.R.G.S., and formed the subject of a paper read before his society in January, 1882. The writer has fully explored Hekla and Krafla and observed their conditions. They are far from inactive and may burst forth at any time with all the violence of the past. Hekla has been quiet longer than its average period and shows strong evidence of an eruption in the near future, unless the pressure is relieved through the many small vents along the line of activity between it and Krafla.

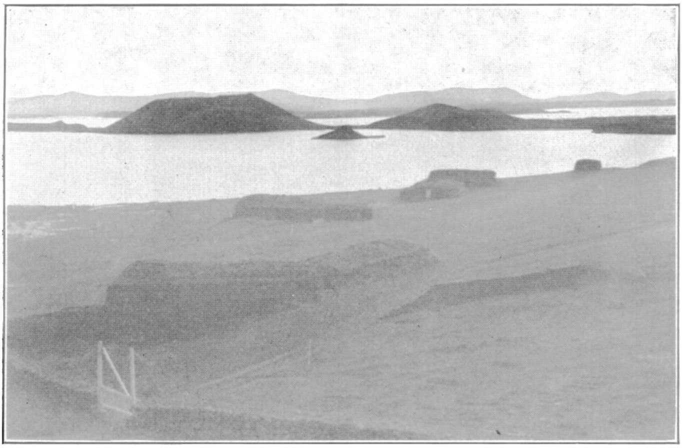

Fig. 3—Mývatn, showing the crater islands with Krafla in the center, thirty miles distant.

The mountains conform to no system. They are all of volcanic origin, very numerous, cone-shaped or weathered into bluffs and pinnacles, and are scattered with the greatest irregularity. Between the mountains there are numerous short and often crooked valleys of considerable fertility, especially in the lowlands or at the terminals of the more ancient glaciers, clothed with luxuriant and nutritious grass and freely sprinkled with a rich and varied Arctic flora. All the valleys have been deeply gouged by glaciers of quite recent geological date and show the work of the iceflow at its best. This is especially true of the Oxnadalr in the north, which is semicircular in cross-section and has not sufficiently weathered to loose the ice markings.

The uplands are wild moorlands or vast wastes of glacier-fractured lava in chaotic mounds and ridges which enclose numerous small sheets of water. A good illustration of the great and unfrequented interior is Grimstungaheithi, which extends from Haukagil southward along the edge of Láng Jökull to Kalmanstunga, a distance of about sixty miles. We ascended the bluff at Haukagill early in the morning and set out upon this great waste which reaches from the fertile valleys of the north to the glaciers of the great central plateau. For a while we found traces of an ancient trail and a few tumble-down cairns which soon disappeared. Hour after hour we plodded along, guided by the irregularities of the ground and the glimmer of the glaciers that loomed higher and higher above the horizon.

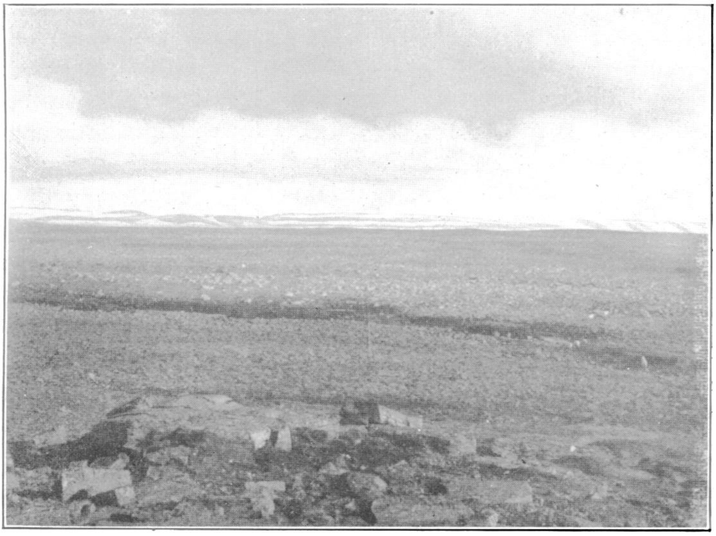

Fig. 4—Grimstungaheithi, characteristic moraine, Láng Jökull twenty miles to the south.

This particular section which we were privileged to examine from horseback is a broad moraine, fresh from the receding glacier, chaotic, empty, vast and dreary. There is nothing to relieve the monotony of the scene save the increasing mass of glittering ice upon the horizon and the piping of the plover with the occasional trumpet of the swan with which the little lakes abound. The angular fragments of lava, somber gray, variously riven and confusedly hurled in piles, as though some vast mountain had been crushed like an eggshell and the fragments scattered by a titanic hand. No touch of verdure relieves the cold ruin and weary waste save at the margins of the numerous glacial tarns which in the distance glimmer like sheets of light. Such is the great interior of Iceland, where man seldom penetrates; areas of lava succeed areas of life-destroying sands only to give place to other areas of glaciers or scorching solfataras.

As in the early days of colonization, so now, the people dwell in a narrow strip of land around the coast, where they have access to the life of the sea, cultivate the lowlands and drive their horses and flocks to the mountain glens for summer pasturage. The population is about 80,000, and outside of Reykjavik, with its population of about 11,000, and one or two towns of 1,000 to 4,000 people, the population is widely scattered.

With the slight exception of a little Pliocene on Skjalfandi Bay, the entire island is volcanic. There are one or two places where traces of lignite occur and these places contain a few fossils of Pliocene time. About 25 per cent. of the rock formation is ancient basalt and another 25 per cent. is composed of ashes, sand and alluvial accumulations. The remainder is about equally divided into post-glacial basalt, post-glacial liparite, pre- and post-glacial dolerite, granophyre, palognitic breccia, conglomerates and tufa. Many of the lavas are rich in beautiful crystals of zeolite. There are two veins of the famed Iceland spar. Copper, in the form of carbonate, is abundant, especiallly in the pass of the Oxnadalr and on the bluffs at Seythisfjord. The vast accumulations of sublimated sulphur would well repay the expenditure of a little capital and energy.

The Mývatn region is one of the most beautiful as well as one of the most awe-inspiring in the country. Mývatn, "Midge Lake," is twenty miles long, the second lake in size, and not over seven feet deep. Many low crater islands dot these waters and hundreds of them fringe the southern shore, giving to the surrounding country an exact representation of the mountains of the moon as viewed through a telescope. Hverfjall is one of the largest of the world's craters, rising from the eastern shore of the lake to an altitude of 700 feet, circular in form, it encloses a central mound of crumpled lava. It is four miles in circumference on the top of the rim. There is no evidence that lava ever flowed from this cone. It is an explosion-crater pure and simple. A force beyond the comprehension of man thrust upward this mighty mass of crust and dropped the fragments of the explosion in the mound above described. The smaller craters are of rare interest. Nowhere else are their peculiar formations duplicated. These hollow, circular cones have a uniform radius and rest upon a level plain with their bases confluent. Their slopes are covered with numberless bombs of the characteristic explosive type. One crater deserves special mention. From this orifice liquid lava was hurled straight into the air. The fiery globules were thrown upward to such a height that they solidified in the air and returned to the crater and around it like a shower of grape-shot. These bombs are round and vary in size from tiny pellicles to croquet balls.

In Vatnsdalr there are conical mounds of crumpled lava so numerous that they have never been counted. Hundreds of acres are covered with these cones. They range from ten to one hundred or more feet in height. Lock and an Icelandic geologist, whose name I can not now locate, believe them to have been formed by upheavals of lava. Another authority in Sweden states that they are merely glacial moraine. After spending a full day in their examination I can not agree with either of these authorities. First, there is no trace of any glacial action on the fragments. Again, there are no evidences of any recent lava flow, either in sheets or intrusive plugs to be found. Lock gathered seventeen specimens of lava on one of them, and I found at least twelve distinct kinds of lava on a cone about ninety feet high. It is my opinion that deep-seated subterranean explosions took place with considerable frequency heav-

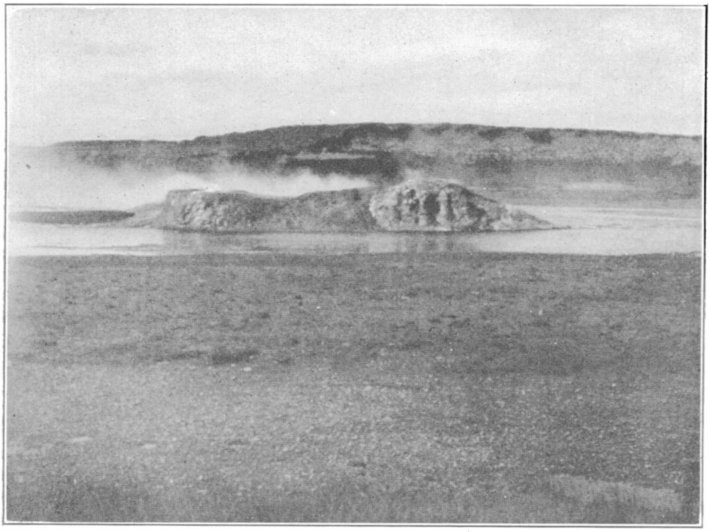

Fig. 5—Geyser in the center of a glacial stream near Reykholt. Note the boiling water at the left end of the geyserite.

ing upward the crust into these crumpled cones and eventually finding vent elsewhere. This is in accord with the explanation given above relative to the formation of Hverfjall.

The form of crater known as "Tintron" in Iceland and elsewhere rare, if found at all, is a tall chimney rising from the level plain with a round hole extending into the bowels of the earth. The interior surface is hung with long, fantastic masses of lava that cooled in this position from the drippings when the liquid material was hurled into the air. There are several around Mývatn, some excellent ones near Húsavik and one not far from Thingvellir. With some difficulty they may be ascended. The view down into the chimney where the lava hangs in shreds, blistered and twisted, is weird and gives to the imagination a vivid picture of the conditions in the days when molten rock shot out of these orifices and dripped sizzling and spluttering back into the nether furnace.

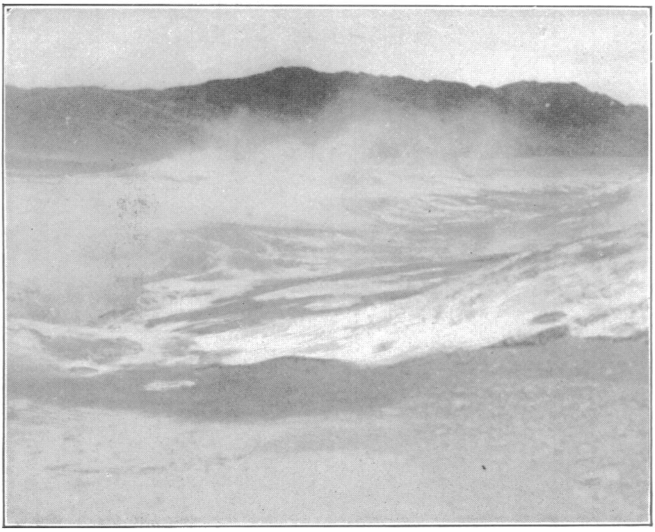

FIG. 6—General view of a portion of the solfatara near the base of Krafla.

A trail from Mývatn leads over the smoking mountain of Námaskarth, where no trace of vegetation is found and where it is necessary to pick one's way with extreme caution among the steaming fumaroles and pools of boiling mud. As far as the eye can range, the mountain is covered with crystals of sulphur, alum and gypsum. The entire northeast slope is thinly crusted and perforated with violent and ill-smelling vents. Great areas of mineral earths rest upon a substratum of viscid, hot and sulphur-permeated clay. The upper crust is composed of sublimated chemicals brought to the surface by superheated gases. The crystals vary in form and beauty with their chemical constituents. As one crunches them under foot he has the sensation of walking with hobnails through a jeweler's show-case. Here one stands at the protoplast of the earth's crust. There are many groups of boiling springs, mud cauldrons, varying from a few feet to thirty in diameter. They are filled with bolus of inky blackness, sulphids of the metals. The location of the cauldrons is not fixed. They often crust over, and new ones from where yesterday it was safe to walk. They boil, spatter, splutter and emit great volumes of steam and sulphur gases. Masses of the hot and sticky stuff are frequently ejected with violent and unexpected explosions.

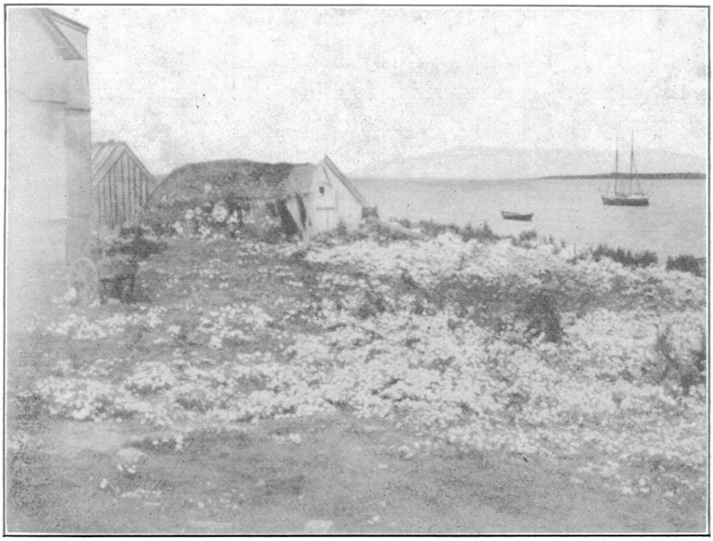

Fig. 7—"Balder's Bra," *Bellis perennis*, dense mass near the shore of a fiord.

The ascent of Krafla is made by a series of zigzag curves over ridges of hot clay, interspersed with ravines of boiling water and masses of volcanic ash. Near the summit there is a large ridge of obsidian in isolated pinnacles, ragged and of the deepest black. It is the purest natural glass. Several craters on the southern slope are filled with water, others are sufficiently hot to forbid a near approach and pour forth continuous volumes of gases with tumultuous sounds. This portion of the mountain is entirely void of vegetation save the algæ in the hot springs. Hidden pools of boiling bolus vomit their horrid contents, and the many deep ravines, worn out of the ash and viscid clay, render exploration arduous and somewhat dangerous.

We decided to descend the unexplored shoulder of the mountain by a spiral route and became entangled in an intricate mesh of deep gullies, ridges of dry ashes and rivulets of boiling and foul-smelling water. Cautiously we proceeded with the laborious undertaking, leading the ponies, searching for a place to descend the slopes and then working much harder to get out, only finding it necessary to repeat the exploit many times. The trusting ponies followed our ignominious slides into the gullies and after much coaxing managed to scramble up after us in a very besmirched condition.

Our route led south across the western desert to the border of the glaciers, Láng Jökull, Eyríks Jökull, Geitland's Jökull and Ok Jökull, with many a stony ridge to climb and glacial torrent to ford. My purpose in this locality was to choose a place for a future ascent of Láng Jökull and to visit the great lava tunnels. South of Eyríks Jökull we came upon an extensive lava sheet, the Hallmundahraun, cracked, crumpled, twisted and tangled. Beneath this lava sheet which fills the broad valley is Surtshellir Cave, the greatest lava tunnel known. Two of these caverns, in form like trolley subways, parallel each other. One has been known for centuries and the other was discovered in 1909. We explored the former, which extends in a straight line for over a mile. It is arched with basaltic plinths and the walls are hung with lava stalactites and nets of lace-like lava in strange, fantastic form. The floor is littered with blocks of every conceivable shape, which time has hurled from the vaulted dome. In places the water has dripped through from the surface to form grand ice stalactites forty-five feet high. Over half the way to the far end of the cavern a wall of ice blocks the passage. By the aid of the strings of lava on the wall we climbed over and gained the slippery summit. Soon after we came to the end of the cave and found the cairn erected by Povelsen in 1753. Upon the capstone, with the wax from our candles, we fastened two Lincoln pennies bearing the date of 1910 as evidence to future invaders of the ancient realm of Sutur that two Americans had gained access to the remote corner of the wierdest lava chamber known. A side passage not far from the entrance contains numberless bones of sheep, horses and cattle. The place was occupied hundreds of years since by Icelandic outlaws, who lived by robbing the farmers to the south. There are no animals in Iceland large enough to carry these bones. The fact that Henderson mentions them in 1817 and Povelsen in 1753 leaves little doubt as to their great age and that they were deposited by the outlaws. I took from this cave the rib of a horse that had been fractured and then mended in the body of the animal. Examination of the surrounding lava sheet leaves no doubt that these lava tunnels were subterranean passages where the liquid lava flowed to a lower level long after it had cooled on the surface.

Several miles south of the cave the Hvitá, White River, plunges over the Barnafoss near Gilsbakki. Its channel is a great rift in the pre-glacial lava flow, which formed the lava tunnels above mentioned, spread over the entire valley and ceased to flow at the very brink of the Hvitá's canyon. The water from the glaciers disappears in the lava several miles above the falls. The Hvitá comes out of one valley and the sheet of lava out of another, and the condition to be described exists at the junction of the two valleys. The glacial river flows for miles under the lava and reappears at the brink of the canyon between the ancient and the recent lava flows. Half way up the bluff the water pours out in a series of waterfalls extending down the canyon for half a mile. In places the water spurts out with evidence of considerable pressure from behind, for it leaps in strong jets into the air to fall into the river below. At the point of contact between the lavas there is a mass of obsidian that was formed in ages past and again became heated and has been

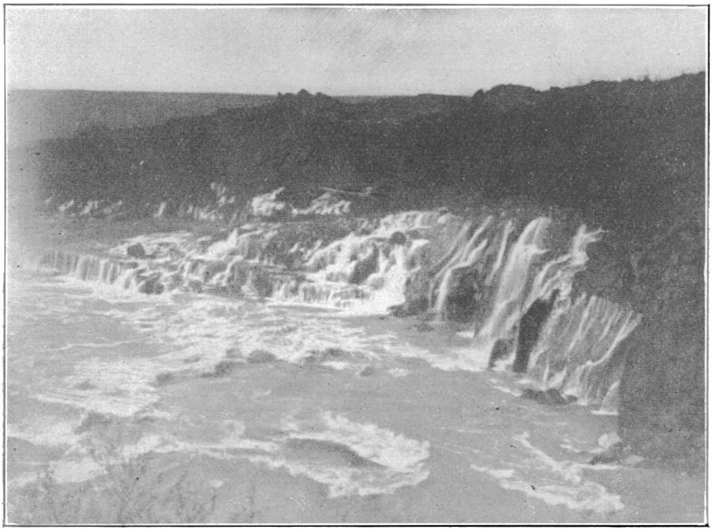

FIG. 8—Water flowing out of the lava into the canyon of the Hvitá. Note the superimposed lava above the half mile of falls.

metamorphosed and pulled and stretched into peculiar forms. To the writer, it is one of the finest views and places for dynamic study in Iceland.

The view from the brink of this canyon across to the ice mountains is one of great beauty. Looking up from the hayfields, the ice-crowned pyramids stand,

> "Like giants clad in armor blue,
> With helmets of a silver hue."

RICE IN THE UNITED STATES

BY

G. T. SURFACE, PH.D.

When European explorers found the new world in their search for an all-sea route to Southern Asia, they and their merchant countrymen conceived the idea of producing in these new lands the chief commodities of import from Africa, Asia and the East Indies. Sugar, tea, spices, indigo, silk, rice and cotton were in demand in Europe, but sugar figured most actively during the fourteenth and fifteenth centuries in industrial experimentation, as well as in trade manipulation. In the early decades of Virginia colonization attempts were made in cotton, silk and rice culture without success. In the Carolinas indigo and tea were added to the experimental list. The production of indigo flourished only temporarily, but cotton and rice maintained successfully a survival struggle, even after the introduction of tobacco from Virginia and sugar cane from Georgia.

Rice had so fully demonstrated its usefulness as a nutritious and easily transported food that persistent attempts were in progress to extend its cultivation in Spain, Italy and the Mediterranean islands; but, on account of the small amount of land adapted to crude methods of irrigation, increase of production had not kept pace with the increase in consumption. The first attempt at growing rice in the colonies was made in Virginia by Sir William Berkeley in 1647, but the inferior adaption of climate and the phenomenal field and market success of tobacco repressed the exploitation of rice, and it remained for South Carolina, a half century later (1694), to realize more encouraging results by planting white East India rice, accidentally obtained from a stranded Madagascar ship. Subsequently,